Seasonal Prediction of North American Wintertime Cold Extremes in the GFDL SPEAR Forecast System

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Motivation: cold extremes have impacts on multiple sectors

People push a car free after spinning out in the snow Monday, Feb. 15, 2021 in Waco, Texas. A winter storm that brought snow, ice and plunging temperatures across the southern Plains and caused a power emergency in Texas stretched its frigid fingers down to the Gulf Coast. (Jerry Larson/Waco Tribune-Herald via AP) *Jerry Larson, AP*

Feb. 2021; cold extreme in Texas;
Source:USA Today
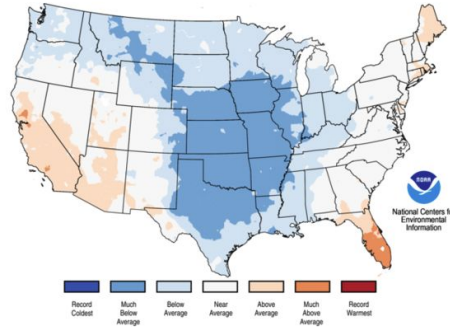
Anomalous cold struck much of the United States in February 2021. Credit: NOAA

Extreme weather, such as the devastating cold spell that hit Texas in February 2021, will occur more often. Nationwide power system planners and operators face the challenge of preparing for future severe events with more weather-dependent power sources. (Image by: Ted Pendergast/Shutterstock.)

WINTER HAZARDS

HYPOTHERMIA: Body temperature drops below 95°F
Symptoms:
- Uncontrollable shivering
- Confusion
- Slow/slurred speech
- Exhaustion
- Poor balance, stumbling
- Drowsiness

Model/Data

**SPEAR (**Seamless system for Prediction and EArth system Research**) reforecasts**

- 0.5 degree resolution in atmos/land; 1 degree in the ocean
- Ocean initial conditions:ocean data assimilation
- Atmos/land/ice initial conditions: SPEAR restoring (CFSR;OISST)
- initialized the first of each month, forecast 12 months
- 15 members;1992-2019 period

Verification data

- ERA5: SST; tmax; snow cover; 500 hPa geopotential height; SST
- Observed Nino 4 index

Definition of wintertime cold days

- A day *d* (in DJF) is defined as a cold day when daily Tmax anomaly < the 10th percentile of day *d*'s Tmax anomaly (relative to 1992-2019 climo) distribution.


from : Zhang et al. 2011
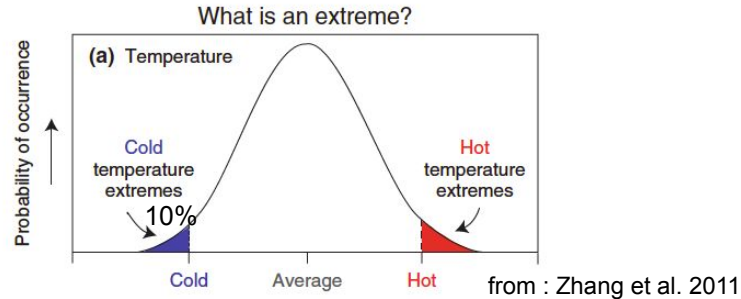
- Based on the 10th percentile threshold, **calculate frequency of cold days (TX10p) in DJF** for each year, at each grid cell in both observations and SPEAR-med reforecasts (for each member and each lead time).

- We study the predictive skill of TX10p (i.e.,the frequency of cold days in DJF).

# Correlation skill of TX10p at leads 0, 2, 6,9 months
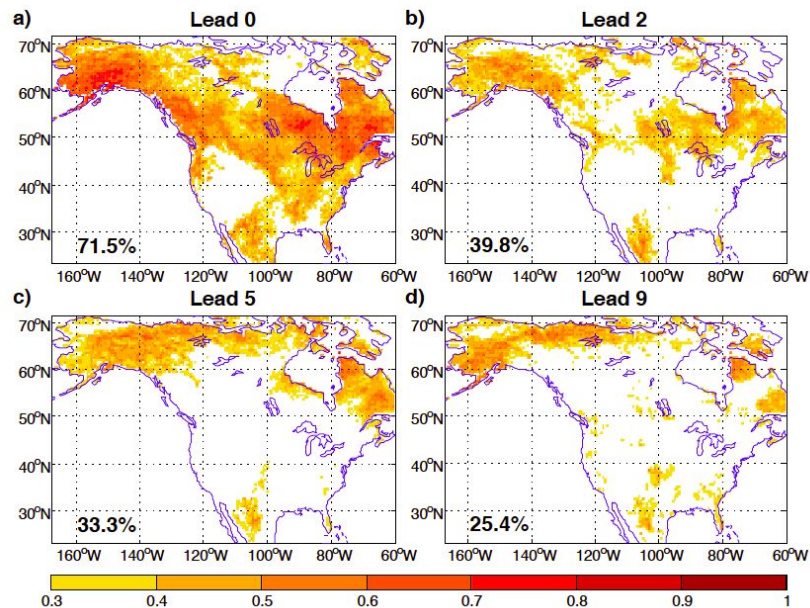
Jia et al. in prep.

Three predictable components of TX10p are skillfully predictable on seasonal scales
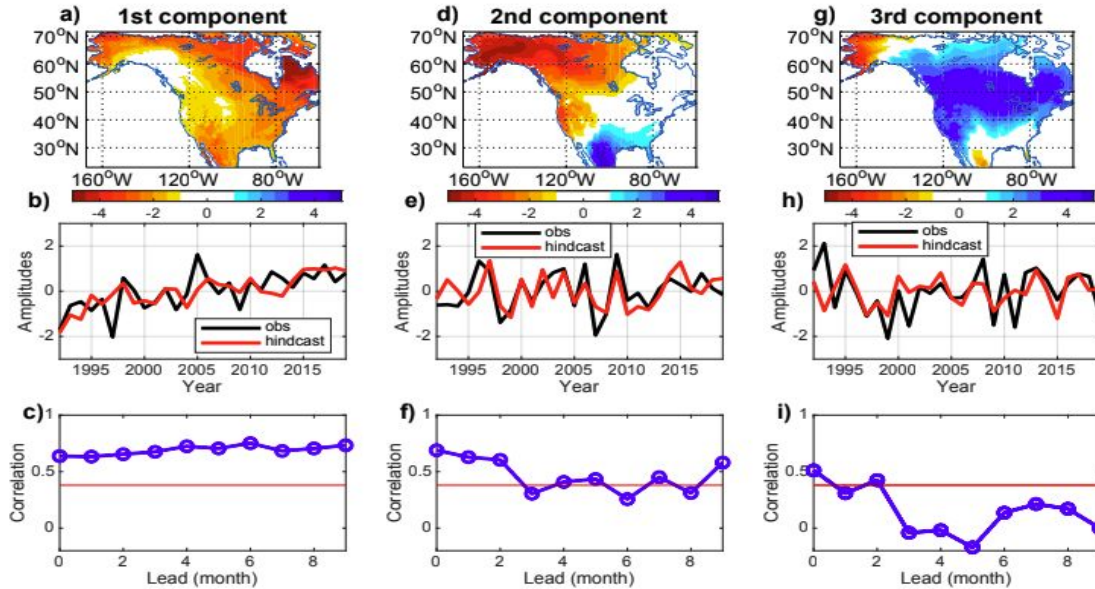
The spatial patterns, time series and correlation skill of three predictable components of TX10p over North American land areas diagnosed using the Average Predictability Time method.
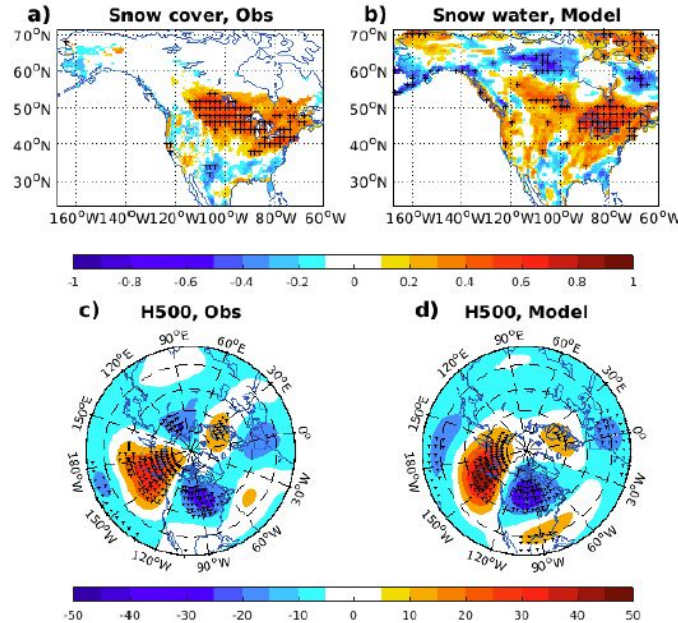
Correlations of SST with the 2nd component
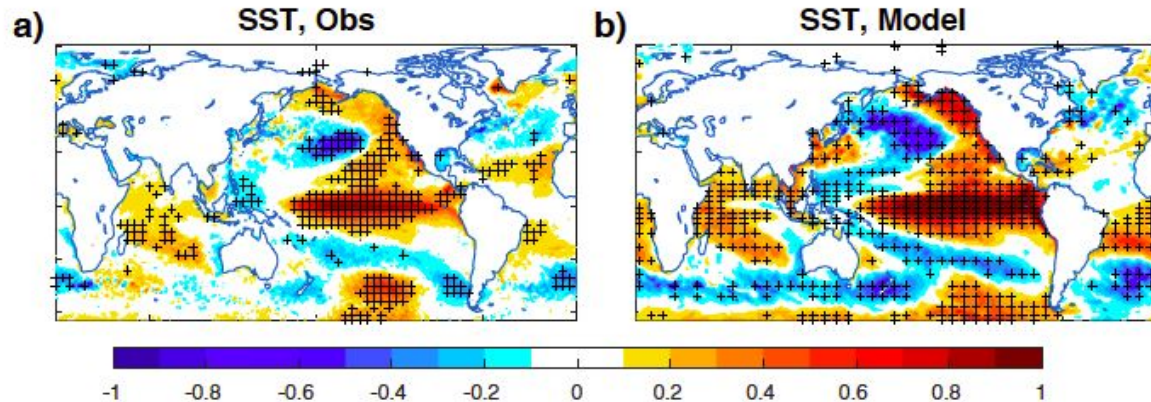
The correlation maps of DJF mean global SSTs with the time series of the second predictable component of TX10p in the observations and SPEAR hindcasts.
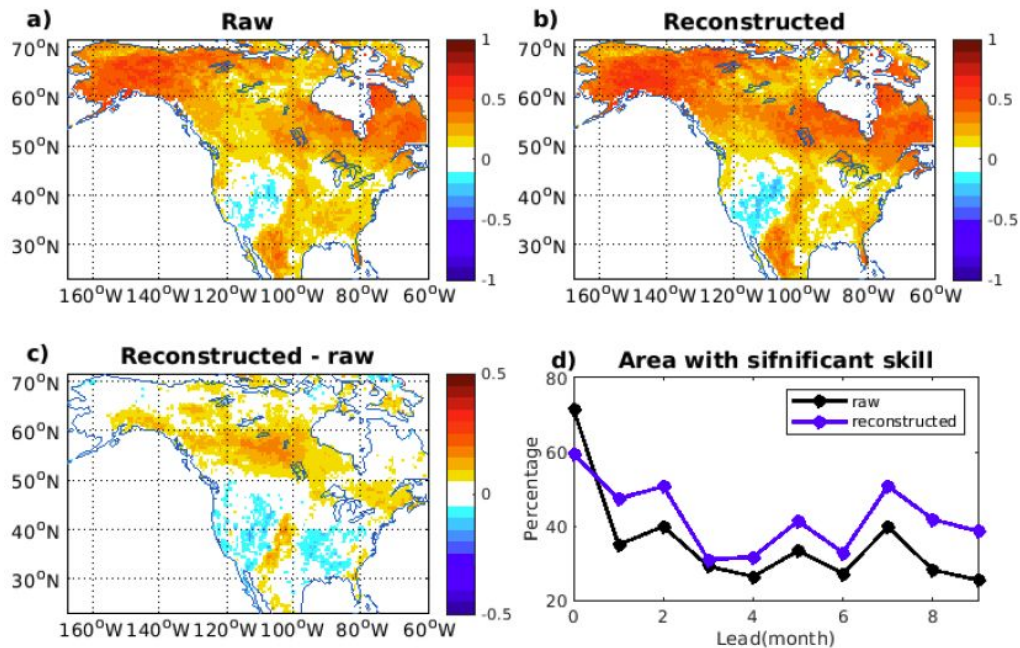
Corr. (regr.) of snow cover (H500) with the 3rd component

(a,b)The correlation maps of DJF mean snow cover (snow water) with the time series of the third predictable component of TX10p in the observations (SPEAR hindcasts). (c,d) The regression pattern of 500 hPa geopotential height in obs (SPEAR hindcasts).

Skill of raw vs. reconstructed with 3 components

Summary

- The frequency of North American winter cold extremes (TX10p) are skillfully predictable on seasonal time scales.

- Global warming, SSTs and snow cover anomalies contribute to the prediction skill of North American cold extremes.

- Reconstructing forecasts using 3 predictable components improves seasonal prediction of the frequency of cold extremes.